

First offshore island record of *Mauremys annamensis* (Siebenrock, 1903) (Testudines, Geoemydidae) in Vietnam

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Abstract. We report the first record of the Critically Endangered Vietnamese Pond Turtle, *Mauremys annamensis* (Siebenrock, 1903), from the Cu Lao Cham Archipelago, Quang Nam Province, central Vietnam, based on two individuals observed in 2015 and 2022. This discovery extends the species' distribution to an offshore island, approximately 17 km from the mainland in Hoi An City, highlighting its potential adaptability and urgent conservation needs.

Key words. Cu Lao Cham Archipelago, distribution record, freshwater turtle, conservation, Quang Nam Province

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INTRODUCTION

Mauremys annamensis (Siebenrock, 1903), Vietnamese Pond Turtle, is a country-endemic and aquatic freshwater turtle. Historically the species was found throughout lowland wetlands and rivers of coastal central Vietnam from Da Nang City south to Phu Yen Province and west into the low-lying inland areas of Gia Lai and Dak Lak provinces (McCormack et al. 2014). The species was first described from Phuc-Son (now known as Phuoc Son District, Quang Nam Province) in 1903 on the basis of a single specimen (Siebenrock 1903). The second finding of the species was documented from Hoi An ("Fai-Fo", Quang Nam) in 1940 by Bourret (Bourret 1940). *Mauremys annamensis* is currently classified as Critically Endangered on both the IUCN Red List (McCormack et al. 2020) and the Vietnam Red Data Book (Nguyen 2023). This species has been observed in the wild for the first time in Fai-Fo (now Hoi An City, Quang Nam Province) in 1939, when it was abundant in ponds and slow waterways (Bourret 1940). Another specimen (female), collected by a U.S. navy corpsman in 1966 near Da Nang City is kept at Columbus Zoo and Aquarium in the United States (Dawson et al. 2013). The Vietnamese Pond Turtle was recorded the last time in the wild in 2006 in Dien Phong Commune, Dien Ban district of Quang Nam Province (a subadult female; McCormack et al. 2007). Both localities lie within the Thu Bon River basin and all known records to date are from the mainland of central Vietnam. Herein, we report for the first time the occurrence of this species on an offshore island based on two individuals discovered during field surveys in 2015 and 2022.

METHODS

Surveys were conducted by the Asian Turtle Program (ATP) of Indo-Myanmar Conservation (IMC) on Hon Lao Island of the Cu Lao Cham Archipelago, Quang Nam Province, 20–23 September 2015 and 13–19 March 2022. Geographic coordinates were obtained using a Garmin GPS MAP 60CSx (Garmin Ltd, Olathe, Kansas, USA) and recorded using the WGS84 datum. Two turtles were observed in local households and subse-



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quently photographed, measured, and then returned to the owners. Tissue samples for molecular analysis were taken from tail tips and stored in 70% alcohol, and subsequently deposited in the Indo-Myanmar Conservation (IMC) collection, Ha Noi, Vietnam. Other data of the individuals were deposited in the database of the Asian Turtle Program (ATP) of Indo-Myanmar Conservation (IMC) with the field numbers IMC 3494 and IMC 3628.

We sequenced a partial mitochondrial gene, the NADH dehydrogenase subunit 4 (ND4). DNA extraction, PCR amplification, and sequencing followed Ngo et al. (2023), except that primers used were ND672 (f) 5' TGA CTACCAAAAGCTCATGTAGAAGC 3' and Hist (r) (5' CCTATTTT TAGAGCCACAGTCTAATG 3') (Arévalo et al. 1994, Engstrom et al. 2002). Raw nucleotide sequences generated were edited using Sequencher v. 4.1.4 (Gene Codes Corp, Ann Arbor, Michigan, USA). Final sequences were deposited in GenBank under accession numbers PV388621 and PV404086. We downloaded three sequences of *Mauremys annamensis* from Genbank with localities from Da Nang City and Quang Nam Province, the nearest locations to the Cu Lao Cham Archipelago (GenBank accession numbers MK726299, MK726300, and MK726301) for comparison. Sequences were aligned using the CLUSTALW (Thompson et al. 1997) option in MEGA v. 11.0.13 (Tamura et al. 2021) with default parameters. Mean uncorrected genetic distances (p -distances, completed deletion option) between sequences were calculated using MEGA v. 11.0.13.

Three main measurements were taken using dial calipers (SHAN 1–300 mm, model 186-314S, China) to the nearest 0.1 mm: maximum length of carapace (L.ca), maximum width of carapace (L.ca), maximum length of plastron (PL), and body mass, which was recorded to the nearest 0.1 g using 2500 g Pesola spring scales (Pesola AG, Schindellegi, Switzerland).

RESULTS

Mauremys annamensis (Siebenrock, 1903)

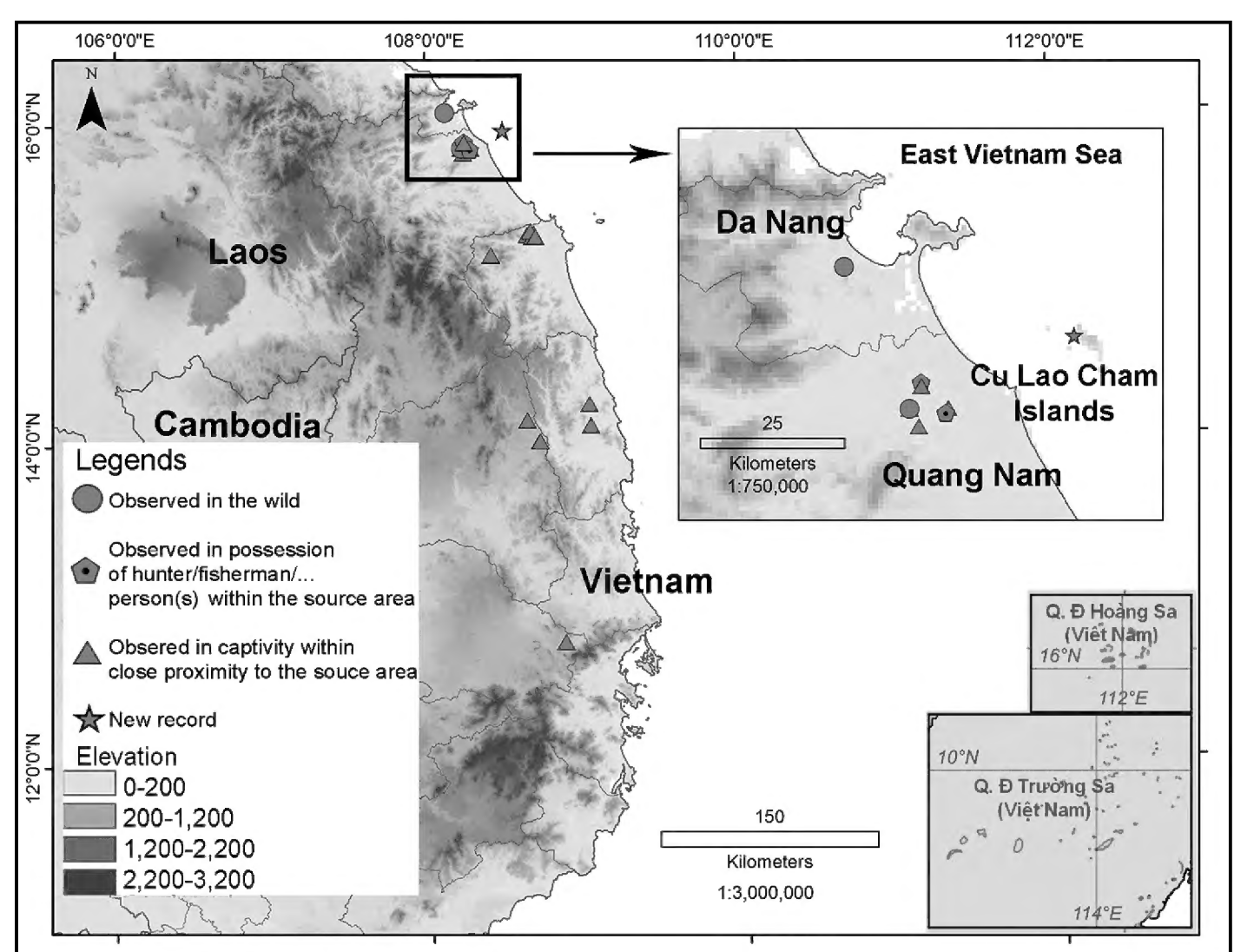
Figures 1, 2

New records. VIETNAM — QUANG NAM PROVINCE • Hoi An City, Cu Lao Cham Islands, Hon Lao Island; alt. 5 m; 20.IX. 2015; L.T. Nguyen obs.; in a local house; GenBank accession number PV388621; 1 ♂, IMC 3494 • Hoi An City, Cu Lao Cham Archipelago, Hon Lao Island; alt. 1 m; 16.IX. 2022; L.T. Nguyen; D.T.T. Tran, S.H. Sam, S.C. Phan obs.; in a local house; GenBank accession number PV404086; 1 ♂ (subadult), IMC 3638.

As turtles of this species are widely traded, we refrained herein from providing precise locality data. However, locality information can be requested for scientific purposes from the first author.

Identification. Genetically, the uncorrected p -distance based on the ND4 gene (final alignment consisting of 819 positions) between our samples from Cu Lao Cham and three samples of *M. annamensis* from Da Nang City and Quang Nam Province revealed to represent 0.6%.

Figure 1. Known distribution range of *Mauremys annamensis* in central Vietnam (see map legend) and new records from the Cu Lao Cham Archipelago, Quang Nam Province, Vietnam (red triangle). Map and data source: IMC.



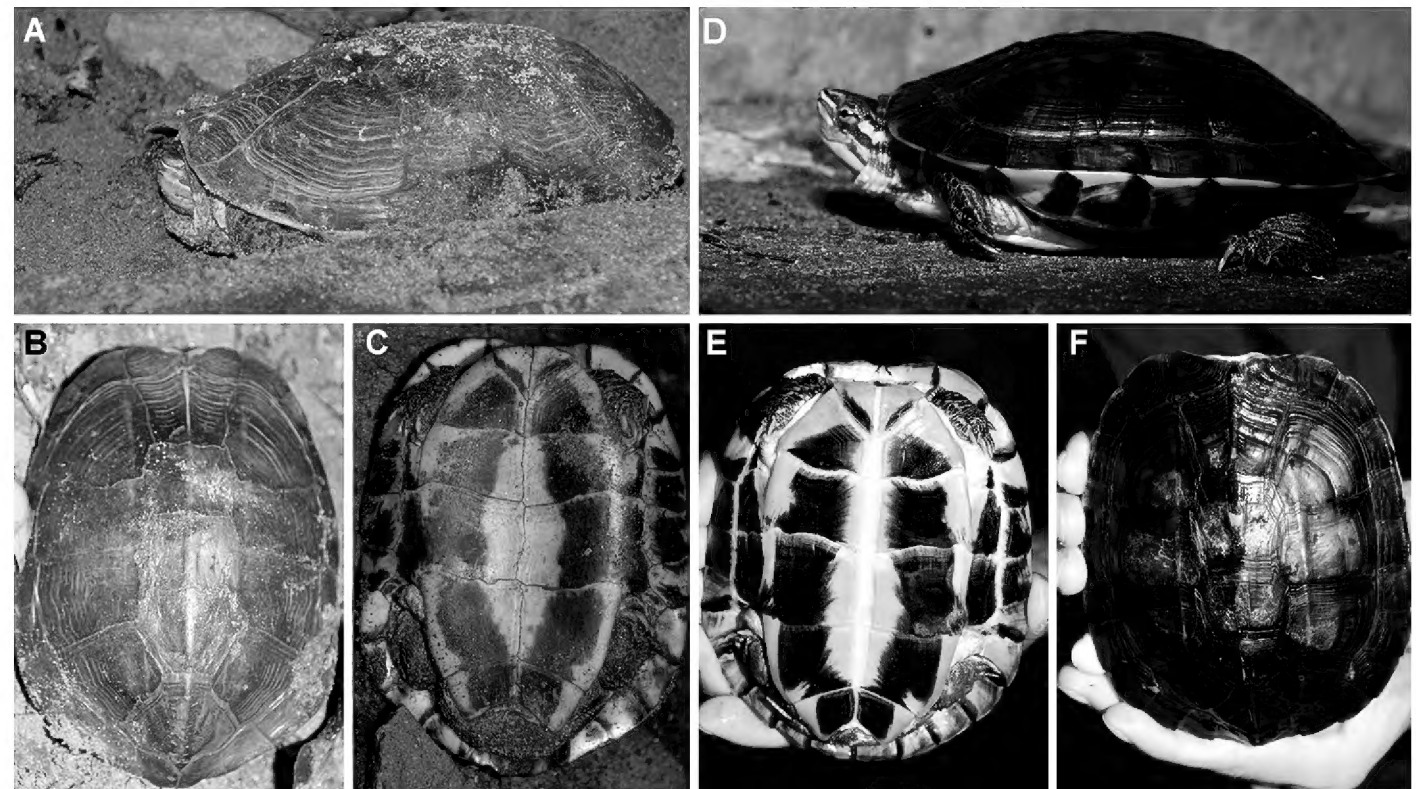


Figure 2. Two new *Mauremys annamensis* record in Cu Lao Cham Islands. **A–C.** Adult male IMC 3094: **(A)** lateral view; **(B)** dorsal view; **(C)** ventral view. **D–F.** Subadult male IMC 3628: **(D)** lateral view; **(E)** dorsal view; **(F)** ventral view. Photos: Nguyen LT.

Morphological characteristics of the newly recorded individuals matched the description by McCormack et al. (2014): the carapace is moderately depressed, rounded from above view, with three longitudinal keels on top. The median keel is best developed, and the two outers are lower; the keels are more developed in the subadult individual. The rear of the carapace is unnotched. The plastron is unhinged and well developed, but it does not completely cover the opening of the shell. The head is pointed, and of moderate size in proportion to the body. The skin on the back of the head is smooth. The toes are fully webbed. The head is dark brown, with three prominent pairs of pale-yellow stripes extending posteriorly from near the tip of the nose on each side of the head. The faintest pair passes dorsolateral over the orbits and ends in the temporal area. The lateral and most prominent pair runs from the nostrils across the orbit and posteriorly along the neck. The third pair extends from below the nostrils along the dorsal border of the jaw, below the tympanum, and onto the neck. An additional set of stripes begins along the inner border of the lower jaw and passes across the jugular region and onto the neck. The carapace is uniform brown, all scutes of the bridges, plastron, and undersides of the marginals include black blotches on a yellow-orange background. The undersides of the posterior marginals are darker than the undersides of the nuchal and adjacent marginals. The outer margin of the plastron is light-colored, while the center of the plastron has a large, contiguous light area that runs across at least the pectoral, abdominal, and femoral scutes. At its widest, the light area is a third to half as wide as the plastron. Chin and the throat spot pale yellow. The neck, limbs, and tail are dark to medium gray dorsally and become lighter gray ventrally. The subadult individual generally is brighter than the older male (McCormack et al. 2014). Measurement and weight of the two newly recorded individuals are provided as follow: IMC 3494: maximum length of carapace (L.ca) 194.6 mm, maximum width of carapace (L.ca) 128.17 mm, maximum length of plastron (PL) 196.05 mm, weight 800 gram; IMC 3628: maximum length of carapace (L.ca) 137.13 mm, maximum width of carapace (L.ca) 105.9 mm, maximum length of plastron (PL) 115.66 mm, weight 325 gram.

According to local people who captured and kept these turtles as pets, the larger individual (IMC 3494) was found under grass, where the finder herded his cows, on 10 September 2015, five days prior to our survey. The recorded location is a small area near a rice field at the mountain's foot in secondary forest, approx. 0.5 km from the stream, and about 2 km from the coast (ca. 36 m above sea level). Based on the information obtained from the owner and our observation of suitable habitat, it can be inferred that the turtle was collected from the wild on Hon Lao Island. The latter one (IMC 3628) was picked up in a small stream in Bai Ong Area on 16 March 2022. The stream runs towards an old rice field. The area, where the turtle was encountered, was covered with wild pineapple bushes and taro plants.

DISCUSSION

Concerning the origin of the individuals recorded from Cu Lao Cham Islands, three main options must be considered: (1) the turtles were introduced from the mainland by humans; (2) the turtles have reached the island on their own; (3) the species has always been part of the local fauna. Hon Lao is approximately 17 km north-east of the mouth of the Thu Bon River. Every year heavy floods from this river transfer floated materials from the mainland into the sea, and thus it is possible that the turtles were passively transferred with these materials to the island. It already has been reported that *Mauremys annamensis* was found clinging onto bamboo in flood water (McCormack pers. obs.). Turtles have been shown that they can survive

long-distance journeys over water. Examples of long marine dispersals of freshwater turtles and tortoises have been documented, for example, for the Nile Softshell Turtle (Taskavak and Akcinar 2008) and giant tortoises (Gerlach et al. 2006; Cheke et al. 2017).

Cu Lao Cham is part of an old Triassic (ca. 252 Ma) rock massif, which includes Bach Ma Mountain of the Hai Van Mountain Range and Son Tra Peninsula in the mainland (Tran 1995). The island was separated from the mainland between 10,000 and 12,000 years ago as a result of the post-glacial marine transgression (Darevsky 1999). Because of this recent separation, apparently there is a close relationship between the herpetofauna from the island and that from the mainland. All the eight species of frogs and 21 of 22 species of reptiles found on the island are also present on the mainland (Phan et al. 2014a, 2014b).

Hon Lao Island is a small island, comprising 1,317 ha. However, it is the biggest island of the Cu Lao Cham Archipelago. Hon Lao Island has forest coverage on low hills with a mostly rocky coastline. It contains only one wetland area with small streams near Bai Ong Village, where the second individual was recorded. This wetland area also is the only suitable habitat for *M. annamensis* on the island. Unfortunately, the area has been heavily developed for tourism in recent years, resulting in an increased number of roads and houses (Nguyen LT pers. obs.). Although some coastal areas of the Cu Lao Cham Archipelago are part of the Cu Lao Cham Marine protected Area, a World Biosphere Reserve (UNESCO 2009), and thus providing protection of some terrestrial insular habitats, none of these protected mainland areas could sustain a natural population of *M. annamensis*. Given that the new insular records of the species are genuine records, pointing to a natural insular occurrence of the species, then it will be crucial in the future to expand the Cu Lao Cham Marine Protected Area to include the terrestrial wetland region on the island to conserve one of, or, if not the last natural, inhabited habitats of the Critically Endangered turtle species. Once the protected area has been expanded and improved protection implemented, further surveys should take place in site, and, if required, genetically screened, purebred and site fitting individuals from conservation breeding holdings released to restock this natural population, which currently is one of the IUCN's One Plan Approach conservation measures within the Vietnamizing conservation campaign of the European Association of Zoos and Aquaria (EAZA) (Ziegler et al. 2024).

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ADDITIONAL INFORMATION

Conflict of interest

The authors declare that no competing interests exist.

Ethical statement

No ethical statement is reported.

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Author contributions

Conceptualization: LNT, DTTT, TEMM. Data curation: LNT, DTTT, SCP. Formal analysis: LNT, ML. Funding acquisition: TEMM, ML, TZ. Methodology: LNT, DTTT, TEMM, ML. Resources: LNT, DTTT. Writing – original draft: LNT, TEMM. Writing – review and editing: LTN, DTTT, SCP, ML, TEMM, TZ.


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Data availability

All data that support the findings of this study are available in the main text.

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